Enclosure 3 (Application No. 10/754,800; Office Action 2, mailed 12/23/2005)

Method of Defense-in-Depth Ultrasound Intrusion Detection

CLAIMS

What is claimed ~~as new and desired being secured by Letter Patent of the United States~~ is:

Claim 1. (Currently amended) Method of defense-in-depth ultrasound intrusion detection that ~~establishes the purposeful interrelation of various techniques of ultrasound intrusion detection with the aim to ensure an early and anticipatory defense-in-depth intrusion protection throughout a multi-echelon and dome-shaped volumetric space around a surveyed critical installation~~ [[.]] provides for sufficient enhancement of the remote ability of airborne ultrasound location of an intruder throughout ~~a~~ near field ~~dome-type volumetric~~ zone and circumjacent ~~dome-type~~ air vicinity of the ~~layout area that both constitute the entire~~ dome-type volumetric room that surrounds a protected object, including the steps of:

~~arranging~~ arrangement of the said entire volumetric room into the physical, tightly ~~adjacent~~ juxtaposed and preferably geometrically closed areas that constitute the spatial multi-echelon openwork structure of the defense-in-depth automatic intrusion protection system; and

commissioning each of said echelons with the particular task of intrusion detection wherein: the central echelon (**C**) containing the enclosed premises of a protected object is being commissioned to detect the intruder's presence and direction of ingress or egress motion; the short-range single-level or multi-sublevel echelon (**S**) of the near field zone adjoining the buildings, works and installations of a protected object is being assigned to detect the presence and locality of an intruder as far as the direction of its motion; the long-range echelon (**L**) of the circumjacent air vicinity of the layout area of a protected object is being charged with detection of the intruder's presence, and speed and direction of its motion; and

rating the size of each particular echelon in the designed prevailing direction of intrusion location to the dimension that should not exceed the distance at which the airborne ultrasound wave attenuates along its incidence and reflection trip to the value less than the dead band of the ultrasonic transceivers where said transceivers are being chosen regarding their operating frequency and prognosticated conditions of the ambient air around a protected object; and

~~applying~~ application of different modes of response of the emitted ultrasound signal, at least the reflection, refraction by edge diffraction and interference with shadowing by an intruded target, in accordance with the task of intrusion detection and presumptive spatio-temporal conditions of

intrusion location in every echelon in particular; and ~~further~~

designing predictive models of intrusion vulnerability of each echelon and the entire area of protected object regarding previously simulated model of presumptive spatio-temporal behavior of an intruding subject or a trespasser along their possible routings; and

plotting the intrusion event tree that reveals cause-effect relations between an intrusion occurrence and subsequent menaces to echelons and their sublevels therein, and to a protected object integrally; and

derivation of mathematical expressions for the system of logical equations of said cause-effect events for every echelon and its sublevels therein, the verifying logical matrix of intrusion justification, the logical decision matrix of inter-echelon cause-effect relations and factors of menaces, the generalized resolving logical equation; and

drawing up the control software algorithm for governing at least: the resolver, based on the system of said echelons' logical equations, verifying logical matrix, logical decision matrix and generalized resolving logical equation; data control block that operates the ultrasound location modes and data acquisition procedure; and system control block that forms and presents the signals of intrusion detection, justification and prevention; and

establishing the software-programmable inter-echelon informational and processing ~~logic~~ logical interrelation among all the juxtaposed and non-adjacent echelons wherein said interrelation is being ~~performed~~ treated and handled by control software algorithm, which ~~realizes~~[[:]] operates the continuous status scan of all the ultrasonic transceivers and oppositely aligned pairs of ~~transmitters-receivers~~ transmitters and receivers in every echelon simultaneously; and which algorithm provides for:

~~the~~ transferring ~~of~~ the acquired data of continuous status scan to the said system of echelons' logical equations, ~~logic~~ verifying logical matrix, and logical decision matrix ~~control software~~;

~~the processing of~~ ability of the said resolver to process the acquired data by the said echelons' logical equations, verifying logical matrix, logical decision matrix and generalized resolving logical equation up to the logically correct decision of the goal function ~~on the basis of the prior model of intrusion vulnerability of each echelon and the entire area of a protected object, and on the basis of simulated a priori the model of the presumptive spatio-temporal behavior of an intruding subject or a trespasser where the said models serve for preliminary plotting the Event Tree~~ of the intrusion detection and protection method; and

~~the~~ creation and ~~issuing the~~ presentation of logically true sequence of the caution and self-checking signals for every intrusion-suspected echelon, signal of intrusion vindication for the

really affected echelon, and final signals of alarm and activation of security measures where the ~~issuing~~ creation and presentation of the said final signals is the goal function ~~being fulfilled as a result of solving the matrix equations that reveal the Goal Function~~ of the new method of ultrasound intrusion detection and protection [[.]]; and

generation of signals of starting said security measures of active and passive protection and defense, which measures include at least: activation of the alarm system, enclosing the physical barriers around the protected works and installations, hence entrapping a trespasser on its actual routing preferably inside echelon **C**, application of disabling tear gas, involving the guard troops, deploying inflatable air obstacles in echelons **S** and **L** or opening the defensive fire therein.

Claim 2. (Currently amended) Method as defined in Claim 1 wherein all the ~~whole of~~ protected dome-type volumetric room around a critical ~~installation~~ object is being arranged in several juxtaposed ~~areas, which areas are being defined as interrelated~~ ~~single-level or multi-sublevel~~ echelons ~~of an entire defense-in-depth intrusion detection space [[.]]~~; where

~~where~~ the indoor single-level or multi-sublevel echelon **C** is being arranged inside the enclosed premises of a protected object, in each of which at least one couple of ~~transmitter-receiver~~ transmitter and receiver is being mounted for inward location of an intruder by ultrasound beam responding in reflection or refraction by diffraction modes; and where

~~where~~ the outdoor single-level or multi-sublevel echelon **S** of the near field zone adjoining the buildings and installations of a protected object is being shaped to consist of 2-D polygonal or curvilinear plane contours, and/or 3-D curved surface areas that are connected into the spatial solid openwork frame, ~~that is being~~ equipped with the pairs of oppositely directed transmitters and receivers, so that all this near field zone has been covered by closely adjacent or even overlapped ultrasound beam patterns, which are being designated to respond either in the refraction mode characterized with diffraction of receiver's beam pattern by intruder's edge, or in the mode of interference featured shadowing a receiver's beam pattern by an intruding subject or trespasser; and further where

~~where~~ the echelon **L** of circumjacent ~~dome-type~~ air vicinity of the layout area of a protected object is being shaped into 3-D curved surface in the form of substantial spatial lattice equipped with outwardly directed transceivers that function by the techniques of ~~preferably~~ constant vectoring or scanning the solid angles that overlap each other, and operate in the mode of continuous emission of ultrasound beams and occasional reception of said beams ~~once having been~~ reflected ~~by~~ from a

target.

Claim 3. (Currently amended) Method as defined in Claim 2, including the steps of: ~~wherein~~

shaping the inner boundaries of outdoor single-level or multi-sublevel echelon **S** of the near field zone in compliance with layout and overground contours of installations and works of a protected object, while shaping the outer frontiers of the said echelon in compliance with layout and outside contours of a headwork and buildings of a protected object; and

~~dividing~~ division of the outdoor echelon **S** of the near field zone into a few sublevels and designing the geometrical shapes and dimensions of said 2-D polygonal or curvilinear contours, or 3-D curved surface areas ~~are being put~~ in ~~correspondence to~~ accordance with:

the spatio-temporal parameters of air-borne ultrasound propagation towards prevailing directions of ultrasonic location in forecasted conditions of the air ambient, while admitting the airborne ultrasound wave attenuation along its one-way emission trip from a transmitter to the opposite receiver to have occurred to the value not less than the dead band of the ultrasonic transceivers [[,]];

the presumptive spatio-temporal behavior of an intruder or trespasser over the terrain of the said echelon of a protected object regarding their possible routings [[,]];~~as far as to~~

the available capabilities ~~of covering~~ to cover all the said surfaces with the ~~appropriate stationary or scanning~~ ultrasound beam patterns ~~during surveillance~~ chosen regarding the said conditions of ultrasound propagation and applied either in stationary or scanning modes of surveillance [[.]]; and

shaping the echelon **L** of circumjacent ~~dome-type~~ air vicinity of the layout area of a protected object so that it is being done open outwardly to the dome-type surveyed room ~~but its~~ whereas the inside geometrically closed frontier of echelon **L** is being configured as the openwork spatial lattice, enveloping the external frontier of the outdoor echelon **S** of the near field zone, otherwise the said both frontiers are being constructed to coincide in part or in full.

Claim 4. (Currently amended) Method as defined in Claims1, 2 and 3 ~~wherein a proper~~, including the steps of:

working out the graphic-analytical model of intrusion vulnerability for each echelon ~~is being composed~~ with regard to the supposed options of ~~supposed~~ spatio-temporal purposeful behavior of intruder or trespasser [[,]] along their possible routings inside premises of the central echelon **C**, around buildings and works of short-range echelon **S**, ~~in the~~ within reach of ultrasound location inside the space of the long-range echelon **L**, where the said options of their ingress or egress routings thru

every echelon are being ~~elaborated~~ searched with taking to account the layout and architectural features of the available protective barriers against an intrusion, and various assumed ways of the trespassers' accessibility to the critical works and installations therein; and

~~verifying~~ verification of ~~which graphic-analytical model is being used for verifying~~ geometrical shape and dimensions of every echelon ~~of the said entire defense-in-depth intrusion detection space~~[[.]] with respect to its ~~pertained~~ predictive graphic-analytical model of intrusion vulnerability where the said verification is being accomplished by comparison of spatio-temporal parameters of intruder's or trespasser's purposeful behavior with spatio-temporal parameters of ultrasound beams' propagation and signaling response in prevailing directions of location.

Claim 5. (Currently amended) Method as defined in Claims 1, 2 and 3 wherein the ~~appropriate~~ technique of ultrasound intrusion detection for each of said echelons ~~that features the distinctive mode of emitting ultrasound signal and registration of its disturbances~~ is being chosen ~~and assigned regarding the type of ultrasonic beam responding, i.e. reflection, refraction by diffraction and interference, which types of ultrasonic beam responding are being respectively selected in compliance with previously composed worked out~~ ~~following~~ in the steps of:

selection of modes of ultrasonic beam ~~responding~~ response regarding the task which particular echelon has been commissioned with and in compliance with previously worked out the predictive graphic-analytical models of intrusion vulnerability for each surveyed echelon[[.]]; and

~~defining~~ definition of the layout chart for ~~disposing~~ disposition of ultrasound transceivers ~~having been~~ distributed inside premises of the echelon **C** and mounted along the circumference of the echelon **L**, and for ~~arranging~~ arrangement of the oppositely aligned pairs of transmitters and receivers along either adverse sides of the integral contour of single-level echelon **S** or adverse sides of the joining contours of juxtaposed portions of ~~multi-level~~ multi-sublevel echelon **S** where the said ~~disposing~~ disposition and ~~arranging~~ arrangement are being schematized in the form of the straight-line or elbow-type rows, planar array or in the spatial lattice for each of the said echelons with respect to the said predictive echelons' graphic-analytical models of intrusion vulnerability and with obeying the requirements to tightly covering at least possible routings of intruders or trespassers with ultrasound beam patterns operating in stationary or in scanning mode of location.

Claim 6. (Currently amended) Method as defined in Claims 1 and 4 wherein the generalized graphic-analytical model of intrusion vulnerability for the entire protected dome-type volumetric room around a critical ~~installation~~ object is being composed, ~~which model is being created with the aim to establish an operatively reliable and functionally correct signal-processing interrelation amongst different~~

~~adjacent echelons based on the principle of early and anticipatory ultrasound detection of ingress or aggress intrusion thereinto~~ [[.]] including the steps of:

~~graphical matching of frontiers of juxtaposed echelons for elimination of dead spots of ultrasound detection and for minimizing the number of transceivers, transmitters and receivers to be used; and~~

~~graphic-analytical estimation of inter-echelon dependable vulnerability at occurrence of one or a few intrusions in one of the echelons, or in some of them simultaneously; and~~

designation of available physical barriers for having used them as hindrances ~~of reaching~~ to access the critical installations and as entrapments along the presumed routings of an intruding subject or a trespasser where this designation is being fulfilled regarding the previously simulated ~~a priori the~~ model of the presumptive spatio-temporal behavior of an intruding subject or a trespasser; and

definition of the territorial contours and limits of ~~operation~~ operating time, ~~violating~~ violation of which with the non-authorized presence or movement of an intruded subject or a trespasser should be considered ~~to be~~ as the actual hazardous intrusion; and

~~assigning the Goal Function~~ of intrusion ~~protection of a critical object as the issuing the signals of intrusion detection, justification and prevention with finalized issuing the signals of alarm and activating of passive and active security measures where issuing the said signals is being accomplished as a result of solving the matrix equations as the logically true decision of the software algorithm.~~

plotting the intrusion event tree in the form of graphic representation or table matrices which identify the interrelations of sublevels inside any echelon, and among juxtaposed or non-adjacent echelons that are based on the sequence of the cause-effect events of registration of an intrusion occurrence and definition of the vulnerability and menaces due to the presence and motion of an intruded subject or trespasser, where

the graphic presentation of intrusion event tree is being fulfilled on the floor plans of enclosed premises of echelon **C** and on the lay-out of the near field zone of echelon **S** for detection of intrusion cause-effect cross-linkages and respective facts of intrusion menaces among sublevels inside echelons, and among juxtaposed and non-adjacent echelons **C**, **S** and **L**; and where

the revealed data of said cross-linkages and facts of intrusion menaces are being used for setting up and analysis of said logical decision matrix, and for setting up said generalized resolving logical equation; and further

setting up the generalized graphic-analytical model itself in the form of graphic-analytical

representation of inter-echelon dependable vulnerability at occurrence of one or a few intrusions in one of the echelons, or in some of them simultaneously.

Claim 7. (Currently amended). Method as defined in Claims 1 and ~~6~~ 5 wherein the diversity of hardware and software of all the techniques of ultrasound intrusion detection ~~involved~~ used in ~~juxtaposed and non-adjacent~~ echelons **C, S** and **L** is being ~~chosen in accordance with said different modes of response of ultrasound signals utilized~~[[;]] ~~and~~

~~where the said hardware and software is being~~ minimized in assortment and power consumption ~~with the aim of consequent assembling the mutual set of instruments and prepare the appropriate software for logically exhaustive the defense in depth intrusion detection signal processing.~~ ~~on~~ in the steps of:

graphical matching of frontiers of juxtaposed echelons for elimination of dead spots of ultrasound detection and graphical prototyping of overlapping the protected areas of echelons **C, S** and **L** completely with beam patterns of chosen transceivers, transducers and receivers ; and

~~bases of the~~ conjugation of specification figures of various ultrasound instruments involved, at least ~~like~~ such as operating frequency and bandwidth of ultrasound emission, S/N ratio, and type of signal processing domain, which specification figures are destined for practicing different modes of response of ultrasound beam patterns, including reflection, refraction by edge diffraction, and interference with shadowing the emitted beam pattern by a target[[,]] ~~which modes should be used in juxtaposed and non-adjacent echelons of intrusion protection room around a critical object~~; and

~~where the architectural minimization of ultrasound processing hardware is being additionally defined by the chosen~~ unification of instrumentation for different modes of intrusion monitoring inside every echelon with stationary vectoring or continuous scanning of all the ultrasonic receivers, for the optional utilization of Doppler detection technique, and ~~by customized~~ for technique ~~application~~ of the automatic emitting-receiving frequency adjustment ~~in the event of sudden~~ under running changes in the ambient air conditions[[;]] ~~and further~~ .

~~where the processing software is being worked out in the form of software algorithm on the basis of information and processing logic matrix, which interprets mathematically the Goal Function of issuing the signals of intrusion detection, justification and prevention in the result of logical processing of caution and self-checking signals, acquired during continuous status scan of ultrasound detectors in all the echelons of the intrusion protection system~~[[.]]

Claim 8. (Cancelled).

Claim 9. (**New**) Method as defined in Claims 1, 4 and 6 wherein

the echelons' logical equations are being set up in advance to reveal the factors of menaces inside the echelons and sublevels therein based on the said graphic-analytical models of intrusion vulnerability that is being estimated by the failure probability of protected facilities, especially of the facilities, belonging to some sublevels in one echelon or to different echelons concurrently; where

the logical decision matrix of the control software algorithm is being designed by placing top-down into the main column all the sublevels of the echelons and entire echelons in the order of defense-in-depth structure, beginning from echelon **L**, and further by arranging all factors of menaces, drawn from the said echelons' logical equations, in the rows against the respective echelons' sublevels and entire echelons in the order of the diminishing rate of said factors of menaces; where

the verifying logical matrix is being designed for carrying out logic analysis for trustworthiness of inter-echelon caution and self-checking signals to avoid untruth propositions during resolution of the goal function by the generalized resolving logical equation of the control software algorithm; and where

the said generalized resolving logical equation is being set up in the result of the analysis of logical decision matrix and generalized graphic-analytical model of intrusion vulnerability with regard to the intrusion cause-effect cross-linkages among sublevels inside echelons, and among juxtaposed and non-adjacent echelons **C**, **S** and **L**.

Claim 10. (**New**) Method as defined in Claims 1 and 9 wherein the goal function of ultrasound intrusion detection is being iteratively resolved during continuous status scan and data acquisition in the steps of:

solution of the echelons' logical equations for justification the fact of intrusion menace; and

carrying-out running analysis of acquired facts of intrusion menaces by logical decision matrix, and

processing the generalized resolving logical equation by the said control software algorithm with respect to the said verifying logical matrix.